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SUBJECT: Apollo 13 Prelaunch Problems -
Implications for Future
Missions - Case 320

DATE: April 28, 1970

FROM: C. H. Eley, III

ABSTRACT

Several problems were encountered during the last few weeks before the Apollo 13 launch. These problems included a higher than expected heat-leak in the LM-SHe tank and impending illness to the CM pilot of the prime flight crew (which necessitated substituting a member of the backup flight crew). It appears that there are some actions which could be taken to reduce the impact of similar problems for future lunar missions.

The higher than expected heat leak of the LM-SHe tank was attributed to a very small amount of GN_2 that had leaked by osmosis into the tank annulus during a storage period of 4-5 years. Since SHe tanks for future missions will experience progressively longer storage periods (and possible similarly degraded vacuums in the tank annulus), an early heat-leak check of the remaining SHe tanks may be appropriate.

Substitution of a prime flight crewman with a back-up crewman may have been a different situation if one of the LM crew had been involved. Considering future missions: (1) changes in training for the backup crew may be required to facilitate substitutions of single crew members, especially for the LM crew with respect to photography, site traverses, LRV operations, etc., (2) backup crew training could be continued right up to launch to facilitate potential crew substitutions, and (3) backup crew training could continue up to launch if the mission slips a month due to weather or mechanical difficulties.

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MEMORANDUM FOR FILE

The major problems encountered during the last few weeks before the Apollo 13 launch included (1) a considerably higher than expected heat leak in the LM-SHe tank, and (2) impending illness to a member of the prime flight crew. The following briefly discusses these problems and points out some considerations that may reduce the impact of similar problems during preparations for future lunar missions.

A. LM-SHe TANK

1. Normal Prelaunch Operations

During pad operations, the first time the LM-SHe tank is filled with LHe is during the Countdown Demonstration TEST (CDDT) at T-48 hours. After an initial fill, the SHe tank is allowed to cold-soak for ~28 hours after which the tank is topped off and pressurized. During the cold-soak period, pressure in the tank begins building due to natural heat leak and is periodically vented. The rate of pressure buildup is carefully noted prior to each venting. Normally, the pressure buildup is initially about 9.2 lbs/hr (spec limit is 10 lbs/hr), which eventually drops to 7.5-8 lbs/hr by T-20.5 hours when SHe toff operations are commenced. LM-SHe operations during launch countdown are identical to those performed during CDDT.

2. Problem Area

During the LM-SHe tank cold-soak period in the CDDT, a considerably higher than expected heat-leak was experienced -- about 17 lbs/hr -- which eventually dropped to just under the 10 lbs/hr spec. limit. The problem was attributed to GN_2 degrading the vacuum in the tank annulus (GN_2 is normally kept in the SHe tanks during storage to prevent corrosion). The hypothesis was that a very slight amount of GN_2 had, over a period of 4-5 years, leaked (by osmosis) into the tank annulus.

3. Implications for Future Missions

As indicated above, the GN_2 in the Apollo 13 LM-SHe tank apparently degraded the vacuum in the tank annulus during storage, a period of 4-5 years. It should be noted that a similar but progressively longer storage period will be experienced by subsequent LM-SHe tanks. The implication for future missions is that the vacuum in some of the tanks may degrade sufficiently to require changeout. It is therefore suggested that it might be appropriate to conduct an early heat-leak check of the remaining LM-SHe tanks.

B. FLIGHT CREW

1. Normal Prelaunch Operations

Until 5-6 weeks before a launch the prime and backup flight crews are supposedly on an equal basis from the standpoint of training. After the Flight Readiness Test (FRT), the training of the two crews diverges with the backup crew serving to help complement the final training of the prime crew for the mission.

2. Problem Area

Shortly after start of the precount operations, it was announced that a member of the backup crew had been exposed to, and possibly had contracted, German measles. Unfortunately, the prime crew was in turn similarly exposed, and later it was determined that the Command Module (CM) pilot (Mattingly) did not have an immunity to the disease as did the other two crewmen. Accordingly, an accelerated training review program was initiated for Swigert, the backup CM pilot, so that he could substitute for Mattingly and thereby save the mission from having to be slipped to the next monthly opportunity in May.

3. Implications for Future Missions

The substitution of a member of the prime flight crew with a backup crewman was fortuitous in that the flight crewman replaced was the CM pilot. Switching a member of the LM crew a few days before launch might have presented a somewhat different situation. The decision to replace the CM pilot on Apollo 13 suggests several considerations for future missions:

- a. Future missions may require a change in training for the backup crew to facilitate similar (i.e. one man) substitutions, especially for the LM crew with respect to photography, site traverses, LRV operations, etc.

- b. Backup crew training could be continued right up to launch to facilitate potential crew substitutions.
- c. Backup crew training could also continue up to launch if the mission slips a month due to weather or mechanical difficulties.

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